DISADVANTAGES, COMPLICATIONS AND TREATMENT OF FUSION SURGERY

The history of fusion surgery

Fusion, which is one of the widely used procedures in spinal surgery nowadays, is a bony union between the two vertebrae (the merger) as a result.

Spinal fusion is widely used approximately hundred years time in the treatment of degenerative diseases of the spine, the lumbar and cervical degenerative disc diseases, spondylolysthesis, painful facet syndrome, spinal trauma, revision of spinal deformations and scoliosis.

Spinal fusion, is defined independently from each other by Hibbs and Albee (1, 2) at the first time and has been accepted as gold standard of the treatment of spine degenerative disk disease over the years.

Looking at the historical development of fusion, Hibbs and Albee had used spinal fusion at the first time for the treatment of Pott disease which is tuberculosis of the spine.

Later, Chandler (3), has used it for the treatment of the lumbalgia and siyataljia for the first time, at years ahead, Barr (4) has used the treatment of low back pain which has been employed after lumbar disc herniations.

Lumbar discectomy with fusion visibility gradually increased after the 1950’s, two to three decades after the 1950’s, fusion started to be widely used. By the 1990’s as high as 50 percentage fusion is most application type of the degenerative disc disease treatment. At these years a lot of fusion techniques developed. Posterior, posterolateral, posterior lumbar interbody fusion (PLIF), anterior lumbar interbody fusion (ALIF), and transforaminal interbody fusion techniques had been widely used. Later 360 degree fusion techniques are improved for maintained stoge fusion at marked instability cases, and accompanied with above mentioned fusion techniques.

Addition to all these techniques for increasing the rate of succesful fusion; internal fixation devices, allografts, bone morphogenic proteins, fusion cages were developed in the last two decades. Firstly, Harrington tried to use bars in his name for stabilization of the spine. These bars were used vertebra fracturs especially instabil ones widely after the 1960’s during the two-three decades. Later on, ROY Camile, Cotrel, Duboussel had used transpedicular screw sytems
and these systems have been used widely through the world. At present, we know the importance of stabilization for successful fusion.

In the short time follow up there was no differences between instrumentationed fusion or non instrumentationed fusion. But, in later years patients who had been non instrumentationed fusion, got deteriorated because of unsuccessful ossification. As a result spinal instrumentation which is applied on the segment, maintains fusion.

**DISADVANTAGES AND COMPLICATIONS OF FUSION SURGERY**

Fusion which is the gold standard for treatment of painful spinal conditions, instabilities, spinal deformities for a long time, gets some disadvantages. Fusion surgery is an invasive procedure and the complication rates increases with the invasiveness of the procedure. As is understood here a simple posterolateral fusion, compared with interbody fusions; interbody fusion has a significantly higher complication rate in patients who underwent. However as a clinical study aggressive fusion procedures do not get any influence at clinical outcome. Even successful fusion can disrupt sagittal balance and causes back pain during sitting.

Widely using of Pedincular instrumentations after 1980’s and using cage devices for fusion, also widespread using of 360 degree fusion surgery after 1990’s; increase successful fusion rate approximately 98%. Increments of fusion rate do not affect the clinical outcomes unfortunately. We evaluate clinical result of lumbar fusion systematically which change from %16 to %95 and satisfactory mean result rate of fusion is %68. Ultimately, even successful fusion, the rate of inadequate treatment of low back pain rate is %30.

Fusion surgery requires longer operation time generally, and blood loss during fusion operation is greater than non fusion procedures. Longer operation time is especially important for elder patients who have degenerative spinal diseases. These patients are at the highest risk group because of comorbidity like DM, heart diseases.

That's why, shorter operation time and less invasive surgery, is more important considering mortality and morbidity. In fusion surgery blood transfusion is more needed comparing the non-fusion procedures. That's another disadvantage of fusion surgery. In the studies lately done, fusion and posterior dynamic transpediculer surgery is compared and both the operation time and blood loss found bigger in fusion surgery. The disadvantages that mentioned aren't seen in
less invasize procedures as posterior dynamic transpedicular systems. That's why, in patients with elder age especially with comorbidities, this method in a good alternative to fusion surgery.

Özer and colleagues compared posterior rigid pedicular stabilization with fusion applied in lumbal disc degenerative diseases and with posterior dynamic pedicular screw rigid rod system applied ones and they found shorter operation time and less blood loss. Also in a newly made clinical study posterior dynamic transpedicular system clinical outcomes are compared with fusion in lumbal degenerative spondililisthesis patients and alike results are gained.

In fusion surgery, patients can come across with some complications in early and late period. These ara complication becaus of bone graft and applied surgery in early period and complication due to bone grafth donor position, pseudoarthrosis and adjacent segment dejeneration in middle and late period.

Autograft use in fusion can cause early or late period complications after surgery. These are infection, acute and chronic pain, pelvic fracture, meralgia prostethica, sacroiliac joint injury and injury of inferior gluteal artery. In spinal fusiongrafting with autograft, the complication rates differ from 1-25%.

Witheraman and colleagues searche 1191 patients with iliac bone graft retrospectively and found that 20% of these patients have complication after surgery. And they found that 3% of these patients have revision surgery. In the follow up of 55% of patients, chronic donor side pain till one year is seen. Also one year long donor side pain in fusion applied patienst with a ratio of 39% is shown in many studies.

The disc distance diminishes and disc length disappears in PLIF applied patients in a newly made study, posterior rigid transpedicular stabilization and fusion applied patients compared with posterior dynamic transpedicular stabilization applied ones, clinically and radiologically. In this study, 12. and 24. month disc distance results of posterior dynamic transpedicular stabilization and fusion surgery are compared and statistically meanful results are gained (p<0,05)

Also in the same study, when the intervertebra disc distance of dynamic group is compared with PLIF applied fusion group, the distance doesn't changes. In this clinical and radiological study it is shown that with posterior dynamic transpedicular stabilization the disc distance in kept becaus of both transferation of load to vertebra's posterior and decline on anterior load. This results in slowness of disc degeneration.
In fact, Pulzier and his colleagues showed that the disc distance degeneration slows down with posterior dynamic transpedicular stabilisation with nucleotomy in lumbar degenerative disc patients. In a prospective study lately done, the lumbar degenerative discs patients with disc hernia are classified according to Carragee disc classification system and posterior dynamic transpedicular stabilisation (with dynamic pedicular screw-rigid rod) is applied to group II, III and IV patients.

In the study that includes approximately two tears follow up result, the observers found that limited discectomy applied patient had slower disk degenerations in their discectomy. As seen in these studies, posterior dynamic transpedicular stabilizations, slows down disk degenerations on the applied segment. Whereas in 360 fusion procedures, lumbar interbody fusions, the disk is totally removed which end in disc distance disturbance and collapsed disk distance no matter which intrument is used or fusion is made.

In spite of fusion, sagittal balance is distruptud and chronic low back pain develops. This is one of the reason of 360 degree fusions bad clinical outcomes with the rate of %30.
Another reason of bad clinical outcome and complication of fusion surgery is pseudoartosis. Pseudoartosis is seen after fusion surgery, but it does not happen after dynamic stabilizations system and surgery tecinques other than fusion.

Pseudoartosis after fusion depends on the vertebra area, how many vertebra is fused, internal fixation is used or not, applied artrodez tecnique, and what kind of bone material (autogreft or allgreft) is used. Smoking osteopenic bone structure, osteoporozis, antiinflamatuar drugs use, methobolic disturbance, immobilization and story of insuffucient fusion, increase risk of pseudoartosis.

Turner and colleagues, searched 47 non-randomizeed study about lomber fussion applied patient data and they found Pseudoartosis is the most complication rate with the rate of %14.they also found that fusion teciques and diagnosis doesnt change the clinical data. But pre operated patient have worse outcomes. The radiological examinations, that is done to determine the diagnosisi why fusion has to be made, are not sensitive. Which leads too higher real pseudoartosis rates. The insidince of Pseudoartosis and vertebra number that fusion applied has a linear proportion. İt is reality that Pseudoartosis rates increases with vertebra level number that fusion made.

In a clinical trial, the fusion rate after on level anterior cervical dickektomy and fusion is %97, but if same procedure is applied in three levels the rate declines
to %83. in a study of BoHLMAN and colleagues, one level fusion Pseudoartosis rate is %11 whereas in multiple level fusion s rate is increases to %27. Pseudoartosis is equal to and smaller than %10 in anterior oan posterior combined fusion. Continuing low back pain and exacerbation in pain brings to mind the Pseudoartosis. Fusion formations can be clearly seen on X ray(lateral & PA) and CT. Especially on lateral X-ray and CT, fusion is better shown.

In X rays, graft mass and continuity, trabecular bridings and existence of abnormal motion, produces information about whether fusion occurred. Pseudoartosis after sometime implant failure occurs. Motion seen on dynamic hyperflexion and hyperextension X-rays will clearly show that fusion does not occurred. Also in Pseudoartosis angulations greater than 10 degree indicates Pseudoartosis. Also in the late periods pedicular screw breakage and loosening is on indicator of undevelopment of fusion, Pseudoartosis and therefore implant insufficiency. Of course the implant insufficiency in early period due to wrong implant application should be excluded from evaluation, screw breakage after fusion occurrence is usually asymptomatic and usually surgery is not necessary. In some patients with Pseudoartosis radiologic diagnosis cannot be made. In this situation, clinical judgement should be in foreground.

İn some patients with Pseudoartosis symptoms like pain does not occur. Also there is %70 rate of successful clinical outcomes in the patients that fusion occurred. That is why, complete clinical remission and a successful fusion correlation can not be demonstrated. Another problem that is seen after fusion is degradations of adjacent segment. The studies showed that fusion can accelerate disc degeneration in adjacent levels. Lehmann and colleagues, showed %50 percent instability of adjacent upper segment and %30 percent spinal stenosis after fusion attempt, in a study that includes long term follow up despite these results, radiological findings showed and correlation with clinical finding.

In the followed up 10 years study penta and colleagues saw adjacent segment degenations in %32 of patients who had anterior lumbar interbody approach. Rahm and hall, searched the patients, that lumbar fusion with instrumantion applied, retrospectively in %35 of patients. They reported that, this situations is related to patients elder age and the use of interbody fusion. Hillbrand and colleagues, reported that the patients they applied anterior cervikal discektomy and fusion, developed symptomatic adjacent segment degenarions in 10 years with 26 percent. The same observers also reported that, there isa %2-3 increase for every years. In adjacent segment disease occurence for every years. According to all these studies, there is a high rate of adjacent segment degenations after successful fusion attempt.
Adjacent segment degenations concept as accepted in literate, is deterioration on the adjacent levels both clinically and radiologically. In asymptomatic adjacent segment degeneration which occurs with the normal aging process. There is radiological degeneration but clinically this deterioration cannot be supported.

The treatment of complications after fusions surgery

Fusion surgery is very invasive procedure with fusion procedure, facet joint, facet joints, lamina and disc structure is deterioriated. Especially in patients with a lean bone structure and osteopenic elder people. Fusion formation is difficult. That’s why screw loosening and Pseudoartosis is more commonly seen in patients who had fusion surgery with instrumentation. Also its shown that the adjacent segment degeneration increase with the age. It is not easy to show Pseudoartosis as a reason of pain in the late period after fusion because of insufficient sensitivity of radiologic investigation. In patients whom is through to developed Pseudoartosis, regeneration always increases the complication risk and new fusion formation rate is low in these patients. In Pseudoartosis revision surgery, because of deterioration of normal anatomical structure, there is a scar formation. That’s why surgery complication and morbidity rates are high. Before the surgery; radiological images of patient who is going to have revision should be made and the normal anatomical structure should be suggested before and working toward the pathological tissue covered with scare will increase success of surgery.

Pseudoartosis surgery it is important to plan the technique for each patient. As a result, because that surgery is going to be a revision surgery, it is going to be contam some difficulties compared to first surgery.

In Pseudoartosis if there is radicular pain with lumbal pain, then the surgery that is going to be done should be decompression with posterior stabilization and fusion. If the previous surgery decompression is applied, there can be unexpected dural tears while decompressing the nerve root because of the epdural fibrosis and adhesions. In revision surgery the bone that is going to be used for fusion should be autogenous. If Pseudoartosis develops after posterior fusion, then again posterior decortication should be made with posterior transpedicular instrumentation and fusion with autograft.

IF Pseudoartosis develops after anterior fusion, the posterolateral fusion with autogenous bone should be made. In the patients with more two disc distance Pseudoartosis, interbody fusion recommended. With anterior approach filling inside of femoral allografts midline with autogenous bone grafts makes powerful stabilizations and accelerates the fusion formation. In Pseudoartosis
some other additional approach are being done to increase fusion formation after revision surgery.

**TREATMENT OF OSTEOPOROSIS**

Even though the effect of medical treatment of osteoporosis on fusion, does not proved it decreases osteoporotic compression fracture incidence, and it has positive effect on fusion ratio and strength. That’s why, in osteoporotic patients, who is going to have fussion procedure, the medical treatment of osteoporosis should be considered.

**ELECTRICAL STIMULATION**

The positive effect of direct electrical stimulations on bone healing is shown in 1950’s from than on it is used in clinical procedure. Direct electrical stimulation increases the fusion rate both on ventral and dorsal fusion. The indications for electrical stimulation are unsuccessful fusion attempt and pseudoarthrosis.

**BONE MORPHOGENETIC PROTEIN (BMP)**

Routine usage of BMP in clinic is early stages.

**OSTEOINTEGRATIONS**

They are substances that bound the bones and distributes loads. They are motionless substances that produce more bigger structural density. The experiments of these substances still keeps on. Another problem seen after fusion is the adjacent segment degeneration that occurs in the upper segment of fusion. The degeneration of adjacent segment, instability and spinal stenosis can be determined clinically and radiologically when adjacent segment disease occurs above the lumbar fusion applied area the thing that can be done in fusion surgery are, shown below.

1) By making decompression on the adjacent segment, fusion could be extended and with fusion this segment can be stabilized with posterior pedicular rigid instrumentation. In this first approach, again on invasive surgery fusion is applied. In the following years, again adjacent segment disease can occur above the operated segment. Also the disadvantages of fusion (pseudoarthrosis, pain in donor site and adjacent segment disease) can be seen on patient.

2) In the revision surgery of patient with adjacent segment disease that 360 fusion surgery (PLIF and posterolateral fusion) applied, posterior rigid pedicular
intrumentation is removed and after making decompression on painful segment surgery is done eith 7 mm revision dynamic pedicular screw and the system is elongated to the upper painful segment. the posterior dynamic stabilization can be done posterior dynamic prodicular stabilization, rigid rod system.

3) In the extented indications of lumbar total disc protheses, adjacent segment instability after fusion surgery is counted. but in this point there is only small number of patient that have been treated with this procedure. long term follow up and clinic work up with larger number of patients is needed.

As a result in symptomatic adjacent segment disease less invasive technique and approach taha does not contain fusion this advantages should be selected. in this approach posterior dynamic transpediculer system. It can be a good alternative for fusion.